D05 FIU SITE CHARACTERIZATION: SUMMARY

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Anne Balsley	CCB Administrator/DCS	11/07/2011

See Configuration Management System for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	12/06/2010	NEON.FIU.000276.CRE	INITIAL RELEASE
B	09/26/2011	ECO-00279	Update to new document number's/template throughout document.

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1 DESCRIPTION

1.1 Purpose

The data summarized here is used to inform the site design activities for NEON project Teams, EHS (permitting), FCC, ENG and FSU. This document summarizes the FIU site characterization data collected, analyzed, and described in the FIU D05 Site Characterization: Supporting Data (AD[01]).

1.2 Scope

This document summarizes the FIU site characterization data for two D05 tower locations: UNDERC site (Advanced), Steigerwaldt site (Relocatable 1), and Tree Haven site (Relocatable 2). Issues and concerns for each site that need attention are also addressed in this document according to our best knowledge.

Disclaimer: all latitude and longitude points are subject to the tolerances of our measurement system, i.e., GPS

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	NEON.DOC.011057 _ FIU D05 Site Characterization Supporting Data.docx
AD[02]	NEON.DOC.011018 _WID between FIU and FCC
AD[03]	NEON.DOC.011008 _ FIU Tower Science Requirements
AD[04]	NEON.DOC.011029 _ FIU Precipitation Collector Site Design Requirements

2.2 Reference Documents

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms
RD[03]		
RD[04]		

2.3 Acronyms

m.a.s.l.	Meters above sea level
m.a.g.l.	Meters above ground level

2.4 Verb Convention

"Shall" is used whenever a specification expresses a provision that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

3 UNIVERSITY OF NOTRE DAME ENVIRONMENTAL RESEARCH CENTER (UNDERC) ADVANCE TOWER SITE

3.1 Desired ecosystem

Table 1. Ecosystem at UNDERC Advanced tower site.

Ecosystem Type	Management activity
Northern hardwood forest	Previously selective logging, currently not logged

The ecosystem around and in the NEON tower airshed at this site is northern hardwood forest dominated by sugar maple. Sugar maple forest is uniform in age and height, and is distributed in most of the area from SSE to west of the tower. Dense sugar maple seedlings cover forest floor with height ~ 0.3 m. Very few trees/shrubs are found between this seedling understory and tree canopy. There was some course woody debris on the forest floor, but not so much to make walking around difficult. There are a large number of ponds and vernal ponds in the vicinity of the tower.

Table 2. Ecosystem and site attributes for UNDERC Advanced tower site.

Ecosystem attributes	Measure and units
Mean canopy height	24 m
Surface roughness[a]	2 m
Zero place displacement height[a]	20 m
Structural elements	Closed deciduous forest, uniform
Time zone	central time zone
Magnetic declination	2° 44' W changing by 0° 5' W/year

Note, [a] From field observation.

3.2 Site Design and Tower Attributes

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 3. Site design and tower attributes for UNDERC Advanced site.

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed area			110° to 280°		Clockwise from first angle
Tower location	46.23388,	-89.53725	--	--	new site
Instrument hut	46.23398,	-89.53716			

Instrument hut orientation vector		--	--	20° - 200°	
Instrument hut distance z		--	--	--	13
Anemometer/Temperature boom orientation		--	--	200°	--
DFIR	46.21704,	-89.51931			
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				8.0	m.a.g.l.
Level 3				16.0	m.a.g.l.
Level 4				24.0	m.a.g.l.
Level 5				27.0	m.a.g.l.
Level 6				36.0	m.a.g.l.
Tower Height				36.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the SSW will be best to capture signals from all wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

Because of the dense forest, we cannot find any open area within 500 m from tower that is large enough to meet USCRN criteria 1 and 2 for **DFIR** (Double Fenced International Reference) location. The closest adequate open area is ~2.33 km away on the southeast toward tower at 46.21704, -89.51931. Because the terrain is relatively flat at this region and few strong convective cells are expected during summer, we assume the precipitation collected at this DFIR location will be representative at tower location as well. DFIR location is ~550 m away from power line on northeast and ~90 m from the Tenderfoot Lake on the west. This DFIR location lies in the state of Wisconsin, while the tower location is inside state of Michigan. But site manager indicated UNDERC owns property in both states. **Wet deposition collector** will collocate at the top of the tower. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here, FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36" (0.914 m). The boardwalk to access the tower is not on any side that has a boom. M. Cramer suggested that it is probably best to use boardwalk to access NEON equipment at this site in order to minimize disturbance. Specific Boardwalks at UNDERC Advance site:

- Boardwalk is from the access point to instrument hut, pending landowner decision
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to the soil array
- No boardwalk from the soil array boardwalk to the individual soil plots
- No boardwalk needed at DFIR site

The relative locations between tower, instrument hut and boardwalk can be found in the Figure below:

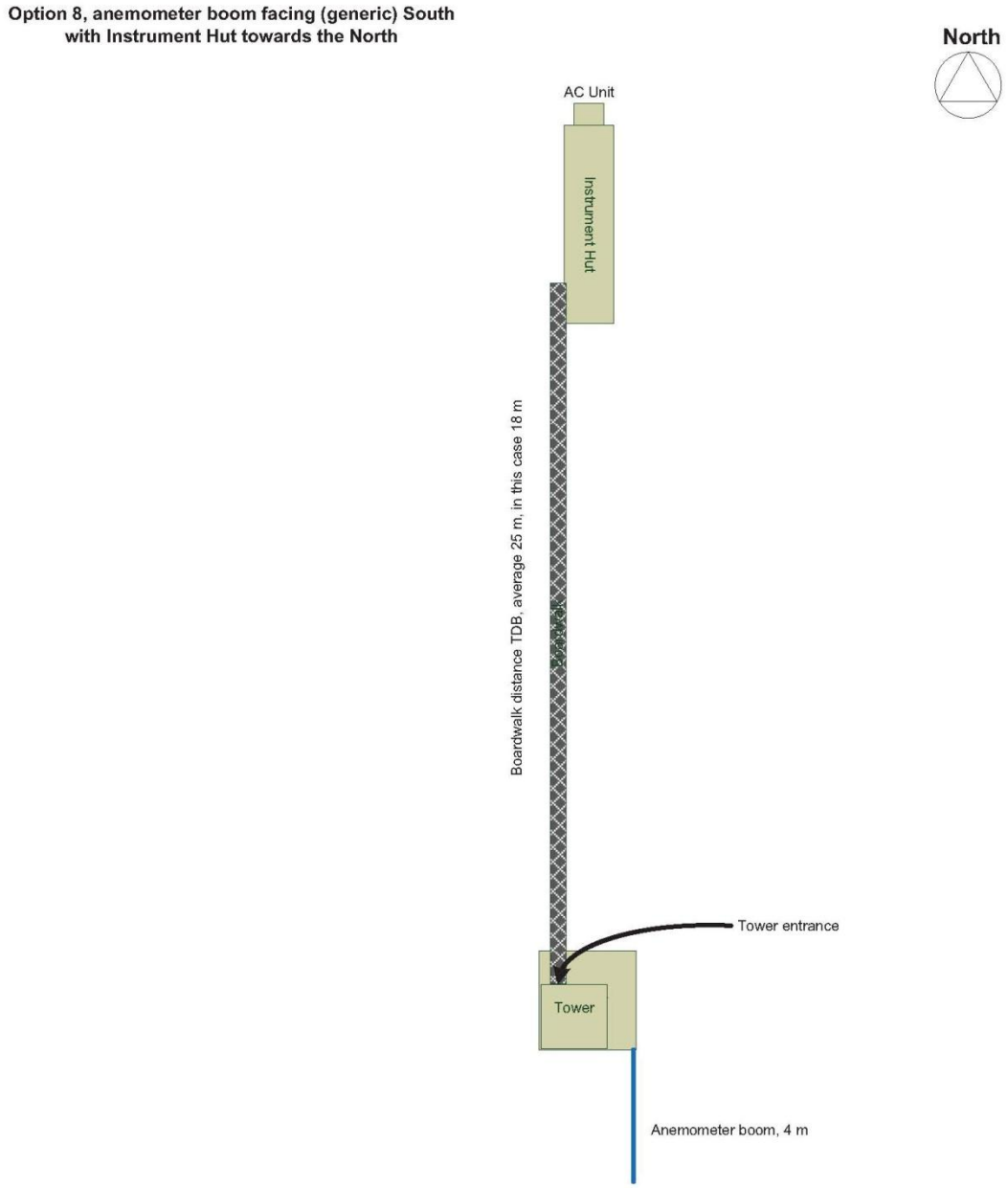


Figure 1. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram. The actual layout of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At UNDERC Advanced site, the boom angle will be 200 degrees, instrument hut will be on the northeast towards the tower, the distance between instrument hut and tower is ~13 m. The instrument hut vector will be SW-NE (20^{o}-200^{o}, longwise).

Figure 2. Site layout for UNDERC Advanced tower site.
i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 110° to 280° (clockwise from 110°) are the airshed areas that would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut. iv) Purple pin is DFIR location

3.3 Soil Attributes

The soil array vector is ***from*** the soil plot closest to the tower ***toward*** the farthest soil plot. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc).

Dominant soil series at the site: Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes. The taxonomy of this soil is shown below:
Order: Spodosols
Suborder: Orthods
Great group: Fragiorthods
Subgroup: Alfic Oxyaquic Fragiorthods
Family: Coarse-loamy, isotic, frigid Alfic Oxyaquic Fragiorthods
Series: Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes

Table 4. Summary of soil array and soil pit information at UNDERC. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	26 m
Latitude and longitude of 1st soil plot OR direction from tower	46.23366, -89.53738
Direction of soil array	205°
Latitude and longitude of FIU soil pit 1	46.23560, -89.53976 (primary location)
Latitude and longitude of FIU soil pit 2	46.236227°, -89.539159° (alternate 1)
Latitude and longitude of FIU soil pit 3	46.237156°, -89.539036° (alternate 2)
Dominant soil type	Gogebic, sandy substratum-Pence-Cathro complex, 0 to 18 percent slopes
Expected soil depth	0.46-2 m
Depth to water table	0-2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.03 m (Slightly decomposed plant material)	0.07 m[A]
0.03-0.13 m (Fine sandy loam)	
0.13-0.20 m (Silt loam)	0.17 m[A]
0.20-0.30 m (Silt loam)	0.25 m
0.30-0.51 m (Fine sandy loam)	0.57 m[A]
0.51-0.84 m (Gravelly fine sandy loam)	

0.84-1.24 m (Fine sandy loam)	1.29 m
1.24-1.37 m (Fine sandy loam)	
1.37-1.73 (Fine sandy loam)	
1.73-2.00 m (Gravelly sand)	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.
[A] Expected depth of soil CO_2 sensors (subject to soil horizon depths)

3.3.1 Information for ecosystem productivity plots

The tower at UNDERC Advanced site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (sugar maple forest). Major airshed area at this site are from 110^o to 280^o (major, clockwise from 110°), and 90% signals for flux measurements during the daytime are within a distance of 700 m from tower, and 80% within 400 m, while during nighttime, some signals collected at tower can be from very far away, beyond 3 km . We suggest FSU Ecosystem Productivity plots are placed within the major airshed boundaries of 110° to 280° (clockwise from 110^o) from tower.

3.4 Issues and attentions

The site commonly experiences ~1 m snow pack between September and May (very likely between October and March). A vehicle weight restriction is enforced each spring due to snow melt (typically ending around May) and it may not be possible to start construction until after this restriction is lifted. Operations should take this into account.

Boardwalk should not cross vernal pools/ponds.

Dirt road can be very muddy and difficult to access after heavy rain, and during mud season (the fifth season between spring and summer)

The DFIR is ~2.3 km from the tower. It was not possible to locate the DFIR closer to the tower due to the lack of forest clearings in this area. UNDERC site personnel would not allow the DFIR to be located in open wetland areas that were closer to the tower.

4 STEIGERWALDT, RELOCATABLE TOWER 1

4.1 Desired ecosystem

Table 5. Ecosystem at the Steigerwaldt tower site.

Ecosystem Type	Management activity
Regenerating forest	Clear cut every 40 years to make paper

The ecosystem around tower and inside the major airshed is aspen dominated regenerating forest. Trees are mainly regenerating saplings from the near clear-cut 10 years ago. Mean height is ~5.5 m and trees grow actively (~0.6 m per year). The mean canopy height will be expected to reach ~ 12 m after 8 years of operation, which is approximately by the time NEON relocatable tower decommissioned at this site. Stem density is very high and estimated to be ~4000 ha^{-1}, but this is likely to decrease as the forest stand matures. It is very difficult to walk through. Some trees at the south end of the site were not harvest in last harvest, and a few mature single trees (~20 m) are dotted around site. The Steigerwaldt site is small (only <400 m E-W direction and <800 m S-N direction). Forest management plots are shrinking at north Wisconsin and Steigerwaldt is considered relatively large in the region.

Table 6. Ecosystem and site attributes for the Steigerwaldt Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height at construction [a]	7.0 m
Surface roughness at construction [a]	1.0 m
Zero place displacement height at construction [a]	5.0 m
Mean canopy height at 8th year of operation [b]	12.0 m
Surface roughness at 8th year of operation [b]	2.0 m
Zero place displacement height at 8th year of operation [b]	9.0 m
Structural elements	Regenerating young trees, actively grow
Time zone	Central time zone
Magnetic declination	2° 32' W changing by 0° 5' W/year

Note, [a] From field survey and best estimates for the time at the construction, which will require top measurement level at 13 m above ground.

[b] Best estimates by the time that NEON tower is decommissioned at the end of the 8 years' services, which will require top measurement level at 21 m above ground, therefore, FCC should design and budget adequate tower height ahead and allow the increase of the top measurement level to 21 m.

4.2 Site Design and Tower Attributes

The ecosystem around tower and inside the major airshed is aspen dominated northern hardwood forest. Trees are mainly regenerating saplings from the clear cut 10 years ago. Mean height is ~5.5 m and trees grow actively (~0.6 m per year). Assume the construction at this site will be in 2012 or 2013, which will give canopy height ~ 7 m. The mean canopy height will be expected to reach ~ 12 m after 8 years of operation, which is approximately by the time NEON relocatable tower decommissioned at this site. The height of seedlings and sapling ranges from 1 m to 5.5 m without obvious strata by the time of FIU site characterization in 2010. The shrub at the site is ~ 2 m tall. Grass forms the understory on the forest floor level with height ~ 0.3 m.

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 7. Site design and tower attributes for Steigerwaldt Relocatable site

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed			190° to 290° (major)		Clockwise from first angle. Winds are from all direction.
Tower location	45.50969,	-89.58498	--	--	new site
Instrument hut	45.50980,	-89.58492			
Instrument hut orientation vector	--	--	45°-225°		
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	225°	--	
Height of the measurement levels*					
Level 1				0.3	m.a.g.l.
Level 2				4.0	m.a.g.l.
Level 3				7.0	m.a.g.l.
Level 4				10.0	m.a.g.l.
Level 5				13.0	m.a.g.l.
Tower Height				13.0	m.a.g.l.

* These dimensions assume a late 2012 construction, see text above. Any change to this schedule the heights would have to be re-calculated.
See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the southwest will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. **Wet deposition collector** will be collocated at the tower top. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36' wide footprint. While the final design is not yet known, there are some general criteria that can be outlined. We assume that the boardwalk width is 36" (0.914 m). Material is not known, but must be fire proof, and in some locations the site is seasonally flooded and inundated with water. Boardwalks may also provide a scratching structure for grazing animals that in turn, would wear and unduly impact the site. Site by site evaluations must be done. Ed Steigerwaldt indicated that it would be ok to use boardwalk at this site.

Specific boardwalks at this site:

- Boardwalk from the access road to instrument hut, pending landowner decision
- Boardwalk from the instrument hut to the tower to intersect on north face of the tower, pending landowner decision
- Boardwalk to soil array
- No boardwalk from soil array boardwalk to individual soil plots.

The relative locations between tower, instrument hut and boardwalk can be found in the diagram below:

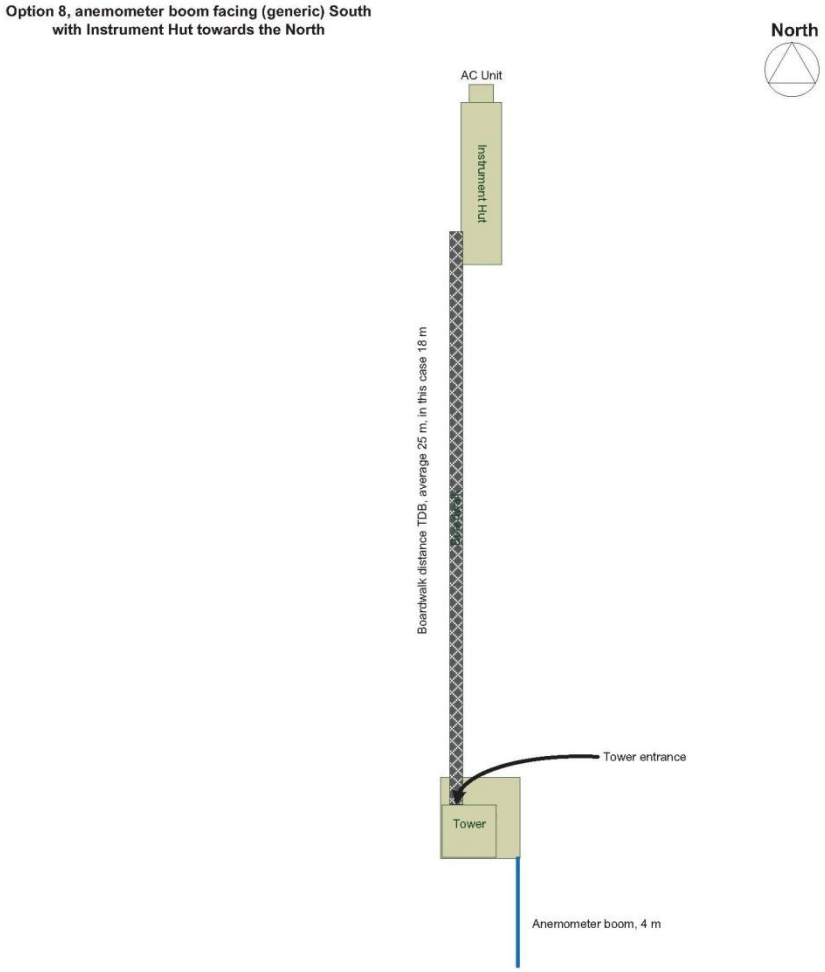


Figure 3. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram when boom facing south and instrument hut on the north towards the tower. The actual design of boardwalk (or path if no boardwalk required) and instrument hut position will be joint responsibility of FCC and FIU. At Steigerwaldt Relocatable site, the boom angle will be 225 degrees, instrument hut will be on the NNE towards the tower, the distance between instrument hut and tower is ~13 m. The instrument hut vector will be NE-SW (45°-225°, longwise).

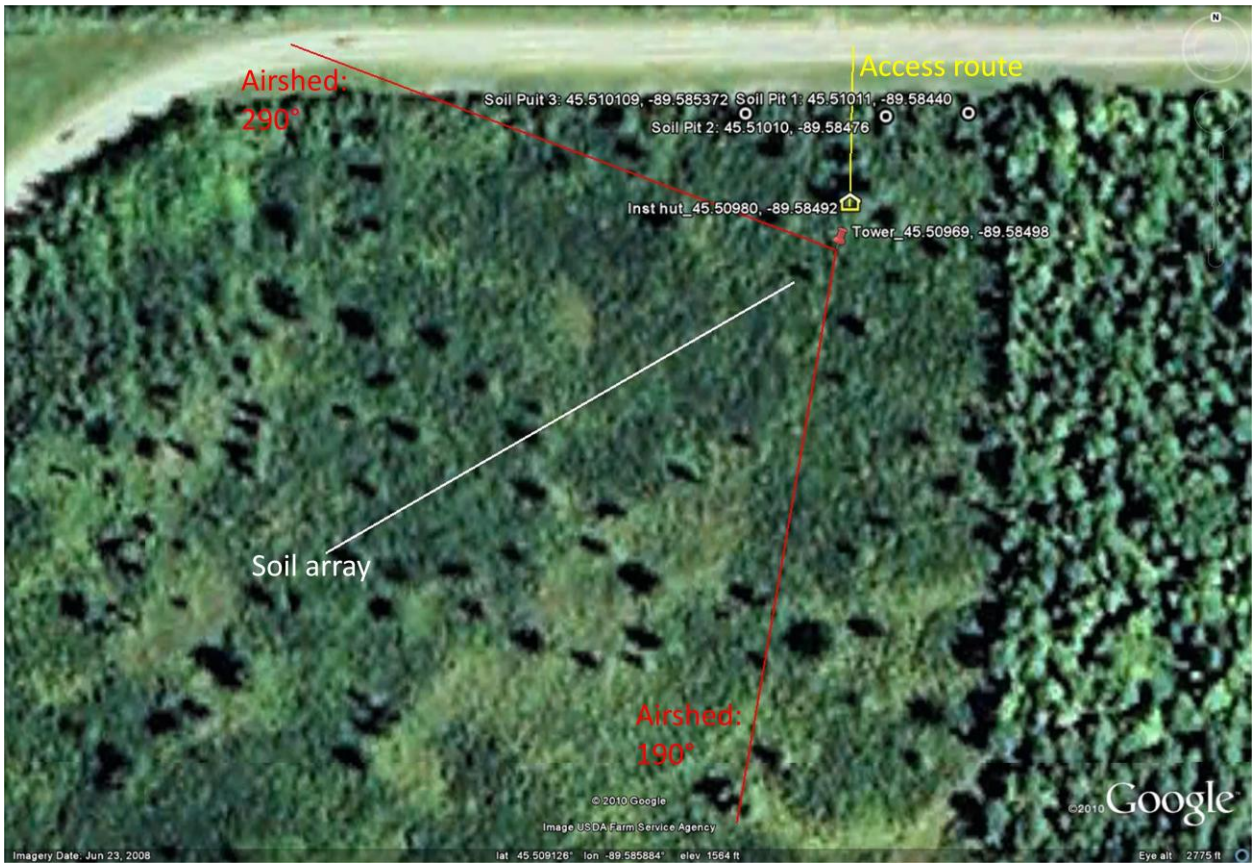


Figure 4. Site layout for Steigerwaldt Relocatable site.
i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 190° to 290° (major airshed, clockwise from 190°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access way to instrument hut.

4.3 Soil Attributes

The soil array vector is ***from*** the soil plot closest to the tower ***toward*** the farthest soil plot. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc).

Dominant soil series at the site: Moodig sandy loam, 0 to 4 percent slopes. The taxonomy of this soil is shown below:
Order: Spodosols
Suborder: Aquods
Great group: Epiaquods
Subgroup: Alfic Epiaquods
Family: Coarse-loamy, mixed, superactive, frigid Alfic Epiaquods
Series: Moodig sandy loam, 0 to 4 percent slopes

Table 8. Summary of soil array and soil pit information at Steigerwaldt. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	18 m
Latitude and longitude of 1st soil plot OR direction from tower	45.509590, -89.585164
Direction of soil array	240°
Latitude and longitude of FIU soil pit 1	45.51011, -89.58440 (primary location)
Latitude and longitude of FIU soil pit 2	45.51010, -89.58476 (alternate 1)
Latitude and longitude of FIU soil pit 3	45.510109, -89.585372 (alternate 2)
Dominant soil type	Moodig sandy loam, 0 to 4 percent slopes
Expected soil depth	>2 m
Depth to water table	0.15 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.08 m (Sandy loam)	0.04 m
0.08-0.13 m (Gravelly sandy loam)	0.11 m [A]
0.13-0.56 m (Gravelly sandy loam)	0.35 m [A]
0.56-1.35 m (Sandy loam)	0.96 m
1.35-1.85 m (Gravelly sandy loam)	1.60 m [A]
1.85-2 m (Gravelly sandy loam)	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.

[A] Expected depth of soil CO_2 sensors (subject to soil horizon depths)

4.3.1 Information for ecosystem productivity plots

The tower has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (aspen dominated regenerating northern hardwood forest). Wind can blow from any direction, but has relatively higher frequency from 190° to 290° (major airshed, clockwise from 190°). Due to the actively growing ecosystem and adjustment of the height of top measurement level over time, tower fetch area will change accordingly. We expect that 90% signals for flux measurements during daytime are within a distance of 600 m – 800 m from tower over the operation period of 8 years, and 80% within 300-500 m. But during nighttime stable calm wind conditions, flux sensor on tower can detect signals beyond 2-3 km from tower. We suggest FSU Ecosystem Productivity plots are placed within the boundaries of 190° to 290° (major, clockwise from 190°) from tower.

4.4 Issues and attentions

Site is very small. Only ~70% flux signals during daytime are within the same management plot of aspen dominated regenerating forest; ~ 30% daytime signal and some nighttime signals will be from the neighboring mature northern hardwood forest in the major airshed between southwest to northwest of

the tower, as well as from north and east of the tower. It will be challenging to intepret the measurement results. However, this cannot be easily avoided in this region, because landownership and forest management practices are from small parcels of properties in this region. Even so, this property is considered to be a relatively large management unit in N Wisconsin.

The plant canopy is actively and rapidly accruing height. Design, construction and operations need to take this into account. During the site characterization visit mean canopy height wass ~5.5 m. We assume the construction at this site will be in 2012 or 2013 and that the tree grow ~0.6 m/yr, which will give canopy height ~ 7 m at construction. The mean canopy height is expected to reach ~ 12 m after 8 years of operation, which is approximately by the time NEON relocatable tower decommissioned at this site. For any change to this schedule the heights would have to be re-calculated.

Power and road access is < 100 m from tower.

5 TREE HAVEN, RELOCATEABLE TOWER 2

5.1 Desired ecosystem

Table 9. Ecosystem at the Tree Haven Relocatable site.

Ecosystem Type	Management activity
Northern hardwood forest	Selective logging to restore northern hardwood forest

The terrain is relatively flat at this site with vernal pools/ponds in low areas. Bogs also exist, being dominated by black spruce and moss understory. The ecosystem at around tower site and in the major tower airshed is restored northern hardwood forest including maple, hemlock, birch, and aspen with an understory of ferns and tree seedlings. The forest is being managed to return it to a northern hardwood forest, which is the typical natural ecosystem in this region. Management activities include selective logging, and around the NEON tower site the selective logging is primarily aimed at removing aspen.

Table 10. Ecosystem and site attributes for Tree Haven Relocatable site.

Ecosystem attributes	Measure and units
Mean canopy height	23 m
Surface roughness [a]	3 m
Zero place displacement height [a]	19 m
Structural elements	Northern hardwood deciduous, multiple layers of understory
Time zone	Central time zone
Magnetic declination	2° 32' W changing by 0° 5' W/year

Note, [a] From field survey.

5.2 Site Design and Tower Attributes

The site layout is summarized in the table below. Assume the projected area of the tower is square. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 11. Site design and tower attributes for Tree Haven Relocatable site

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan to best match the surrounding environment.

Attribute	lat	long	degree	meters	notes
Airshed area			190° to 290°		Clockwise from first angle
Tower location	45.49457,	-89.58505	--	--	new site
Instrument hut	45.49465,	-89.58493			

Instrument hut orientation vector	--	--	45° - 225°		
Instrument hut distance z	--	--	--	13	
Anemometer/Temperature boom orientation	--	--	225°	--	
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				1.5	m.a.g.l.
Level 3				0.8.0	m.a.g.l.
Level 4				10.0	m.a.g.l.
Level 5				23.0	m.a.g.l.
Level 6				27.0	m.a.g.l.
Tower Height				35.0	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the southwest will be best to capture signals from all major wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

Secondary **precipitation collector** for bulk precipitation collection will be located the top of tower at this site. No **wet deposition collector** will be deployed at this site. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack becomes uneven causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. Here FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36' wide footprint. While the final design is not yet known, there are some general criteria that can be outlined. We assume that the boardwalk width is 36" (0.914 m). Material is not known, but must be fire proof, and in some locations the site is seasonally flooded and inundated with water. Boardwalks may also provide a scratching structure for grazing animals that in turn, would wear and unduly impact the site. Site by site evaluations must be done.

Specific boardwalks at the Tree Haven Relocatable site

- Boardwalk is from the access forest road to instrument hut
- Boardwalk is required from the instrument hut to the tower to intersect on north face of the tower
- Boardwalk to soil array is required, pending landowner decision.
- No boardwalk from the soil array boardwalk to the individual soil plots

The relative locations between tower, instrument hut and boardwalk can be found in the diagram below:

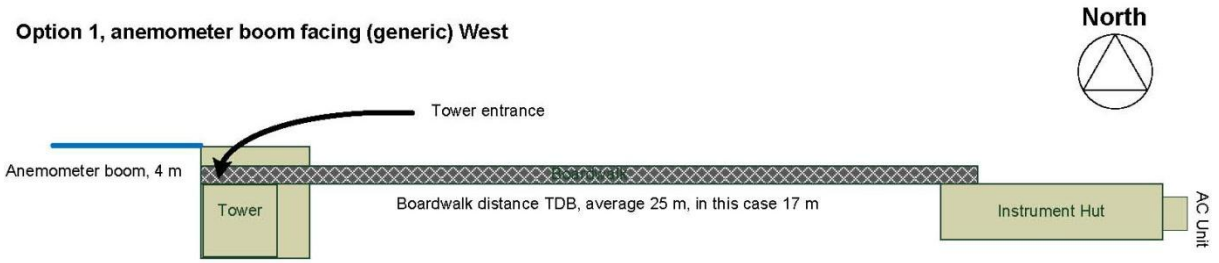


Figure 5. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing west and instrument hut on the east towards the tower.

This is just a generic diagram. The actual layout of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At Tree Haven Relocatable site, the boom angle will be 225°, instrument hut will be on the northeast towards the tower, the distance between instrument hut and tower is ~13 m. The instrument hut vector will be NE-SW (45°-225°, longwise).

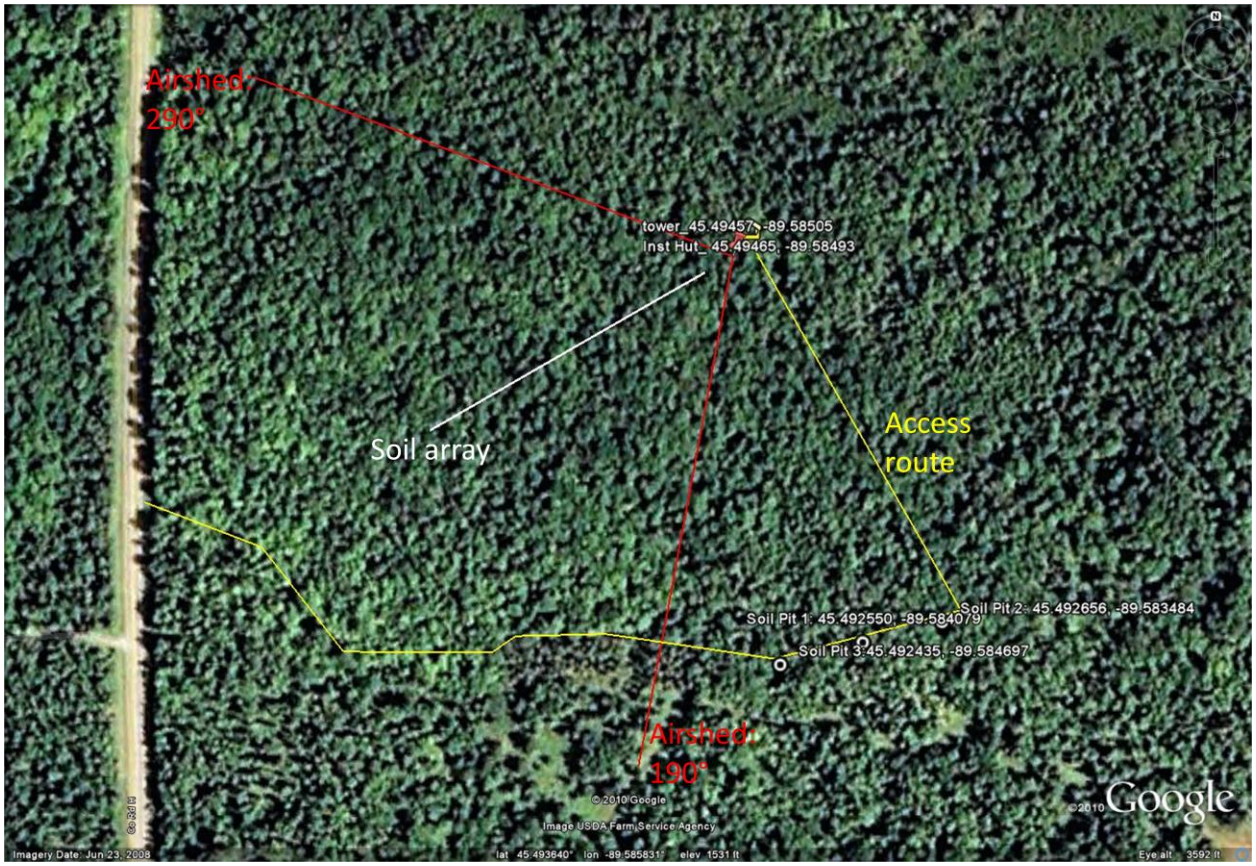


Figure 6. Site layout for Tree Haven Relocatable site.

i) new tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 190° to 290° (major, clockwise from 190°) would have quality wind data without causing flow distortions, respectively. iii) Yellow line is the suggested access road to instrument hut.

5.3 Soil Attributes

The soil array vector is ***from*** the soil plot closest to the tower ***toward*** the farthest soil plot. The exact location of each soil plot will be chosen by an FIU team member during site construction to avoid placing a soil plot at an unrepresentative location (e.g., rock outcrop, drainage channel, large tree, etc).

Dominant soil series at the site: Sarwet sandy loam, 2 to 6 percent slopes- Moodig sandy loam, 0 to 4 percent slopes. The taxonomy of this soil is shown below:
Order: Spodosols
Suborder: Orthods -Aquods
Great group: Haplorthods -Epiaquods
Subgroup: Alfic Oxyaquic Haplorthods -Alfic Epiaquods
Family: Coarse-loamy, mixed, superactive, frigid Alfic Oxyaquic Haplorthods -Coarse-loamy, mixed, superactive, frigid Alfic Epiaquods
Series: Sarwet sandy loam, 2 to 6 percent slopes- Moodig sandy loam, 0 to 4 percent slopes

Table 12. Summary of soil array and soil pit information at Tree Haven. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	B
Distance between soil plots: x	40 m
Distance from tower to closest soil plot: y	19 m
Latitude and longitude of 1st soil plot OR direction from tower	45.494485, -89.585261
Direction of soil array	240°
Latitude and longitude of FIU soil pit 1	45.492550, -89.584079 (primary location)
Latitude and longitude of FIU soil pit 2	45.492656, -89.583484 (alternate 1)
Latitude and longitude of FIU soil pit 3	45.492435, -89.584697 (alternate 2)
Dominant soil type	Sarwet sandy loam, 2 to 6 percent slopes-Moodig sandy loam, 0 to 4 percent slopes
Expected soil depth	>2 m
Depth to water table	0.15-0.61 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.08 m (Sandy loam)	0.04 m [A]
0.08-0.13 m (Gravelly sandy loam)	0.12 m [A]
0.13-0.56 m (Gravelly sandy loam)	0.35 m [A]
0.56-1.35 m (Sandy loam)	0.96 m
1.35-1.85 m (Gravelly sandy loam)	1.60 m
1.85-2 m (Gravelly sandy loam)	2.00 m

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.
A Expected depth of soil CO2 sensors (subject to soil horizon depths)

longwise).

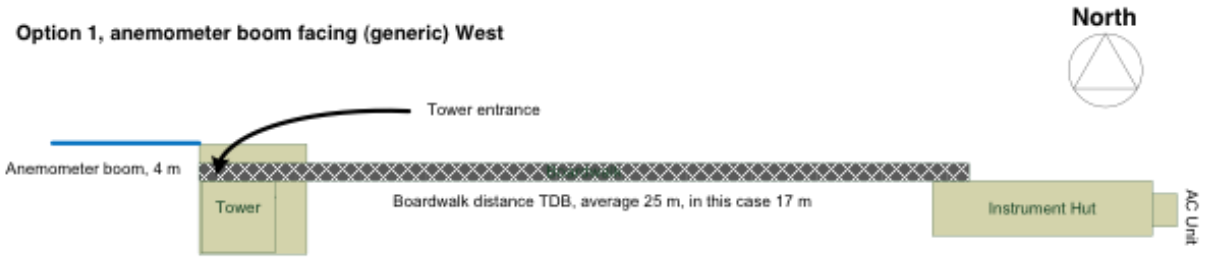
5.3.1 Information for ecosystem productivity plots

The tower at Tree Haven relocatable site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (mixed northern hardwood forest). Wind can blow from any direction, but has relatively higher frequency from 190^{o} to 290^{o} (major airshed, clockwise from 190°), and 90% signals for flux measurements during daytime are within a distance of 1000 m from tower, and 80% within 600 m. But during nighttime stable calm wind conditions, flux sensor on tower can detect signals beyond 3 km from tower. We suggest FSU Ecosystem Productivity plots are placed within the boundaries of 190^{o} to 320^{o} (major, clockwise from 190°) from tower.

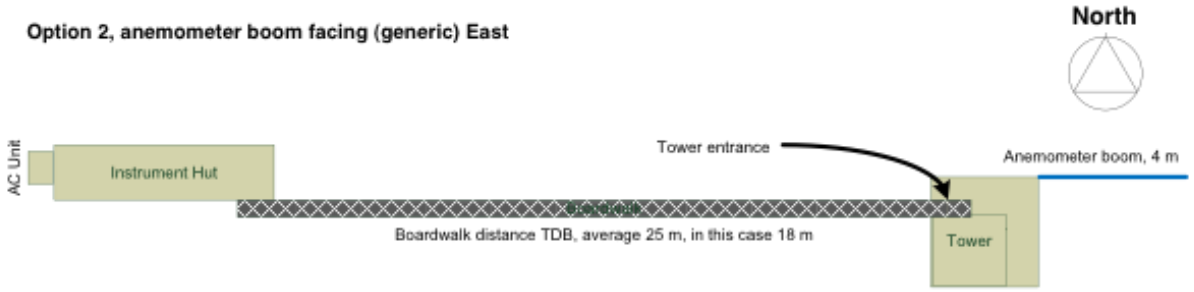
5.4 Issues and attentions

The tower location is close to the northern, western, and southern property boundary. Approximatly 70% flux signals during daytime are within the same management unit on the east side of the road, and ~ 30% daytime signal will be from the forest on the west side of the road. However, the forest on the property to the north and west of the tower are similar to the forest in Tree Haven (i.e. northern hardwood). The forest on the property to the south was harvested in ~2002 and is regenerating northern hardwood forest and is unlikely to be harvested for decades. The county highway, ~350 m west of the tower, is not heavily used and vehicle emissions are not expected to be high.

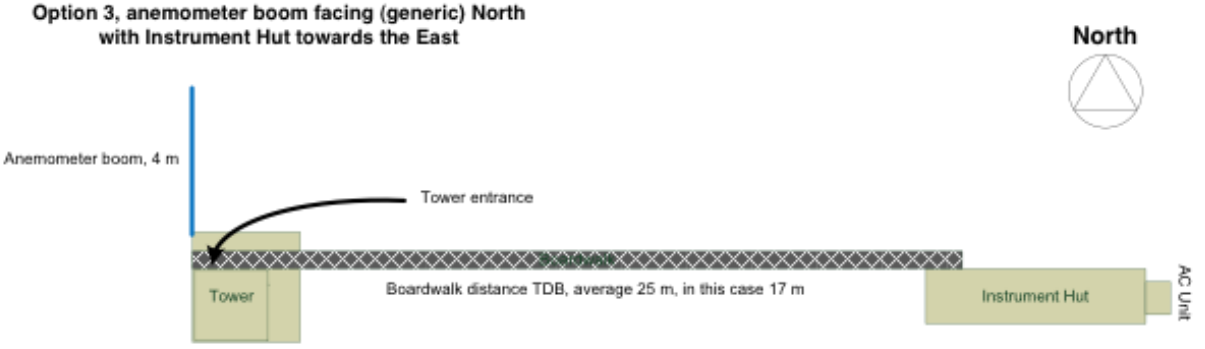
Option 1, anemometer boom facing (generic) West



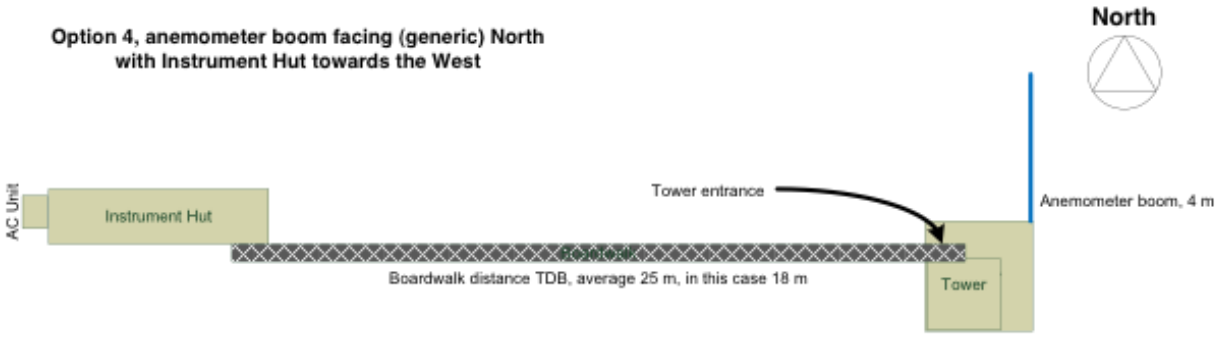
Option 2, anemometer boom facing (generic) East



Option 3, anemometer boom facing (generic) North with Instrument Hut towards the East



Option 4, anemometer boom facing (generic) North with Instrument Hut towards the West



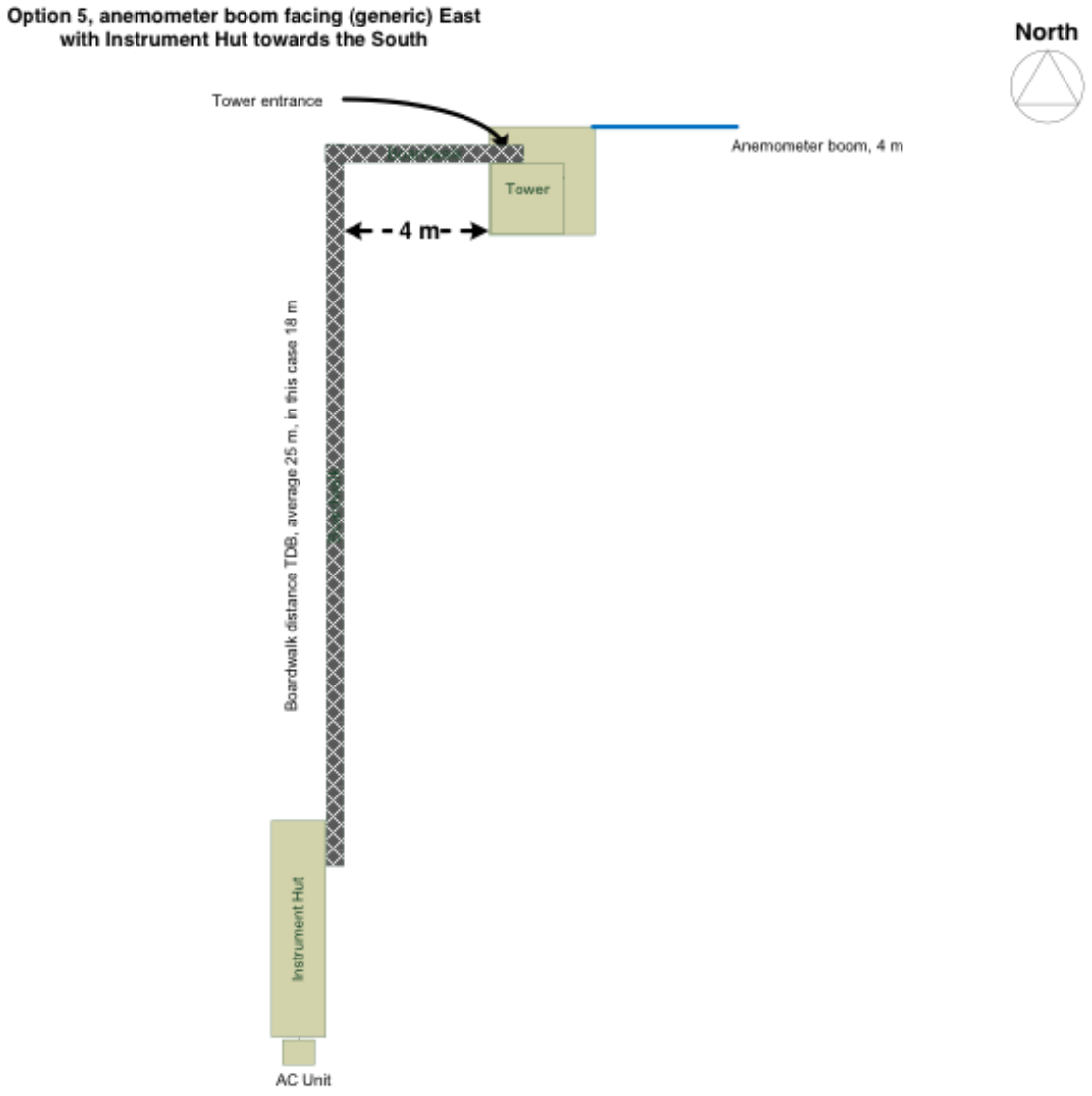
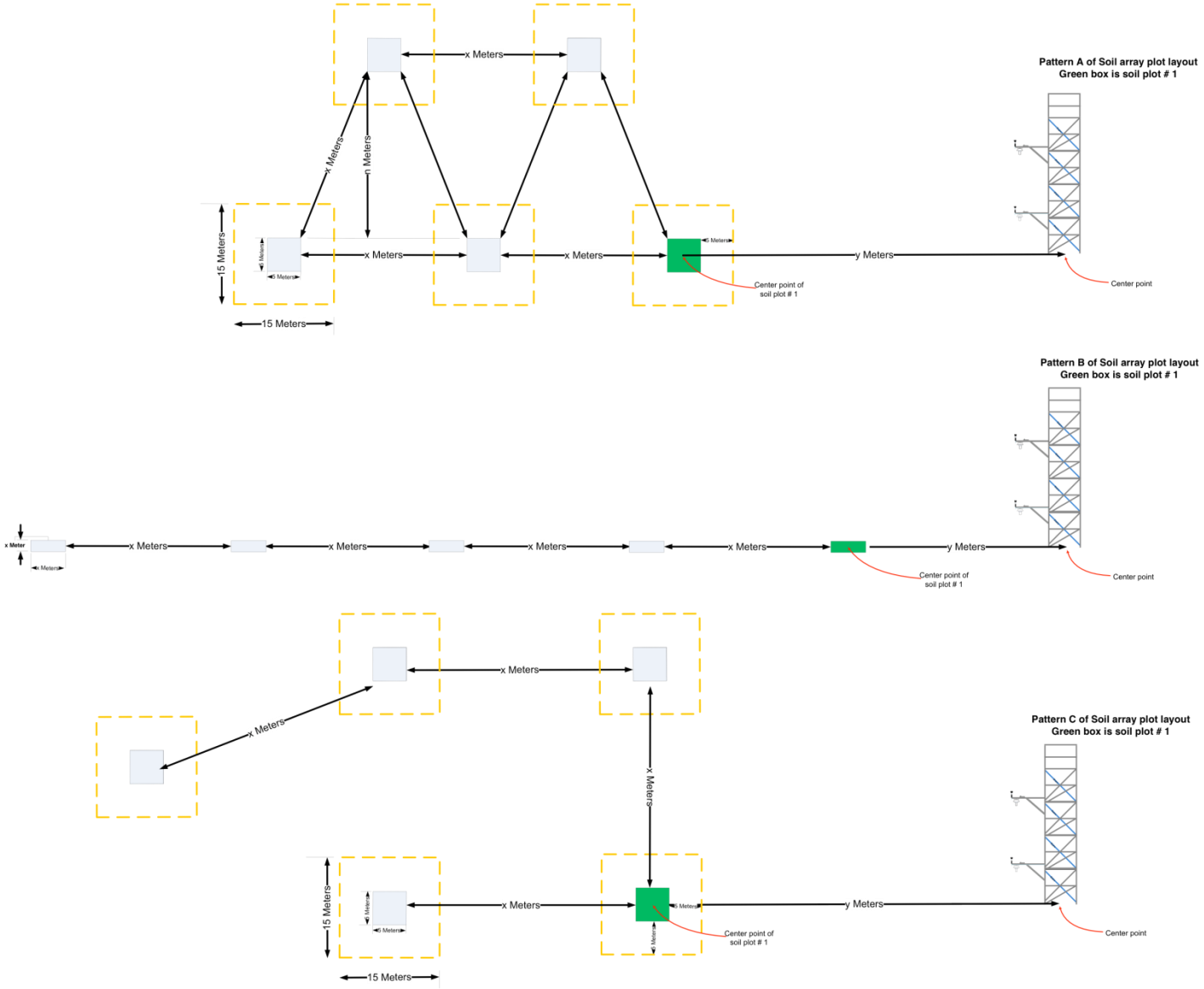


Figure 7. Generic patterns for the boardwalk configuration

These generic configurations are from the instrument hut to the tower based on 5 generic scenarios. The five options are based on anemometer boom orientation and the leeward side of the tower where the instrument hut is located. The tower entrance is always on the North side of the tower. Exact tower and instrument hut location and orientation will be specified at each location and presented in the site characterization document.


Pattern A of Soil array plot layout
Green box is soil plot # 1
x Meters
x Meters
x Meters
15 Meters
15 Meters
x Meters
x Meters
y Meters
Center point of soil plot # 1
Center point
Pattern B of Soil array plot layout
Green box is soil plot # 1
x Meter
x Meters
x Meters
x Meters
x Meters
y Meters
Center point of soil plot # 1
Center point
Pattern C of Soil array plot layout
Green box is soil plot # 1
x Meters
x Meters
x Meters
15 Meters
15 Meters
x Meters
y Meters
Center point of soil plot # 1
Center point

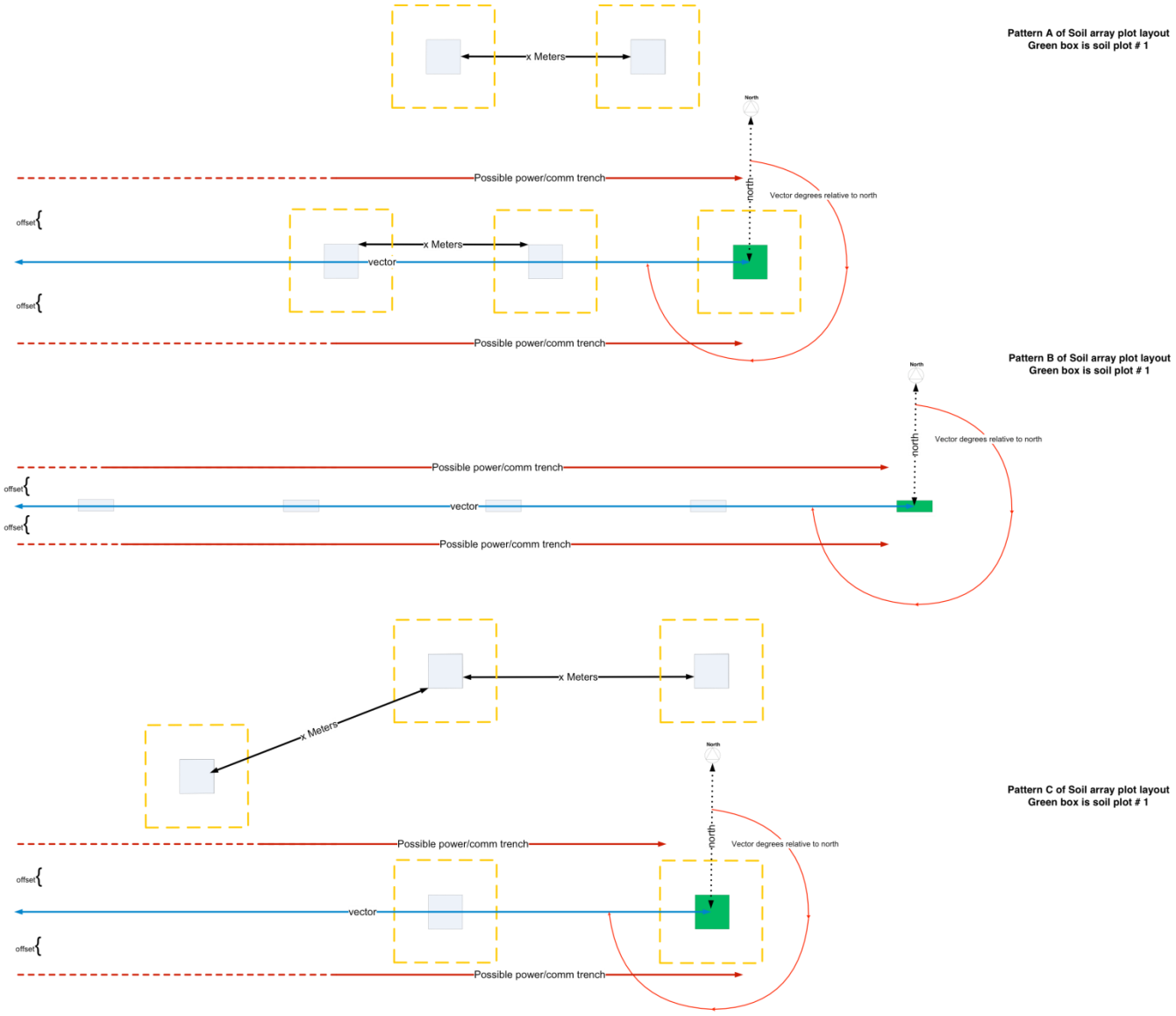


Figure 8. Conceptual diagram of Soil Array Patterns

Outlines the orientation for the soil array and instrument hut from the center point of the tower. The x, y, z distances are i) the distance between soil plots, ii) distance between the tower centerpoint and the closest edge of soil plot, and iii) the distance between the tower centerpoint and the closest edge of the instrument hut, respectively. The yellow outline around each soil plot is the 5 m perimeter keep out zone.

6 APPENDIX A. FCC SUMMARY TABLES

Table 13. FCC Summary Table for FIU site components at D05 UNDERC Core

Site Component				**units**
Tower location	46.23388,	-89.53725		Lat, Long, in degrees
Tower location	46° 14' 1.9674"	-89° 32' 14.1"		Lat, Long in deg min sec
Tower height[f]	36			meters
Tower guying	yes			yes/none, notes
Instrument Hut location	46.23398,	-89.53716		Lat, Long, in degrees
Instrument Hut location	46° 14' 2.328"	-89° 32' 13.776"		Lat, Long in deg min sec
IH orientation[a]	20° - 200°			vector
boom orientation[b]	200°			degrees
distance from center of tower to IH center (z)		13	option 8	distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the Northeast.			description
Air shed vector(s)[c]	110° to 280° (major)			Vector, clock wise from first angle
Boardwalk from AP to IH	yes, from dirt road to IH	(see Figure 2)		yes/none, notes
Boardwalk from tower to soil array	yes			yes/none, notes
Boardwalk needed to DFIR	none			yes/none
Power and Communication line	10 m from edge of plot to centerline of the power/comms line	Whichever side is easier [e], line above ground		offset, notes
DFIR location	46.21704,	-89.51931	No BW	Lat, Long in degrees, notes
DFIR location	46° 13' 1.3434"	-89° 31' 9.516"		Lat, Long in deg min sec
DFIR power supply	30 amp AC power from tower			description
Soil plot 1st location	46.23366,	-89.53738		Lat, Long in degrees (center point)
Soil plot 1st location	46° 14' 1.176"	-89° 32' 14.5674"		Lat, Long in deg min sec
Soil plot distance between plots (x)	40 m	26 m		x, y (meters)
Soil array pattern and vector[d]	B	205°		A, B, or C, vector

Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	46.23560,	-89.53976	0.46 m to 2 m	Lat, Long, and expected depth
Soil profile pit primary	46° 14' 8.1594"	-89° 32' 23.136"		Lat, Long in deg min sec
Soil profile pit alternative 1	46.236227°,	-89.539159°	0.46 m to 2 m	Lat, Long, and expected depth
Soil profile pit alternative 1	46° 14' 10.4166"	-89° 32' 20.9718"		Lat, Long in deg min sec
Soil profile pit alternative 2	46.237156°,	-89.539036°	0.46 m to 2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	46° 14' 13.761"	-89° 32' 20.529"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	None			description
Site management*	Previously selective logging, currently not logged			description
Any additional site specific information	Closed deciduous forest, uniform			description
Magnetic declination	2° 44' W changing by 0° 5' W/year			At time of site visit

Table 14. FCC Summary Table for FIU site components at D05 Steigerwaldt Relocatable 1

Site Component				**units**
Tower location	45.50969,	-89.58498		Lat, Long in degrees
Tower location	45° 30' 34.8834"	-89° 35' 5.928"		Lat, Long in deg min sec
Tower height[f]	13 m at construction, 21 m at the end of 8th year of operation			meters
Tower guying	No			yes/none, notes
Instrument Hut location	45.50980,	-89.58492		Lat, Long in degrees
Instrument Hut location	45° 30' 35.2794"	-89° 35' 5.7114"		Lat, Long in deg min sec
IH orientation[a]	45º-225º			vector
boom orientation[b]	225°			degrees
distance from center of tower to IH center (z)		13	Option 8	vector, distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from the northeast.			description
Air shed vector(s)[c]	190° to 290° (major)			vector, clockwise from first angle
Boardwalk from AP to IH	yes	(Figure 4)		yes/none, notes
Boardwalk from tower to soil array	yes			yes/none, notes
Boardwalk needed to DFIR	no DFIR			yes/none
DFIR location	none			Lat, Long
Power and Communication line	10 m from edge of plot to the centerline of the power/comms line	Whichever side is easiest[e], above ground		offset, notes
DFIR power supply	na.			description
Soil plot 1st location	45.509590°	-89.585164°		Lat, Long (center point)
Soil plot 1st location	45° 30' 34.524"	-89° 35' 6.5904"		Lat, Long in deg min sec
Soil plot distance between plots (x)	40 m	18 m		x, y (meters)
Soil array pattern and vector[d]	B	240°		A, B, or C, vector
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	45.51011,	-89.58440	>2 m	Lat, Long, and expected depth
Soil profile pit primary	45° 30' 36.3954"	-89° 35' 3.84"		
Soil profile pit alternative 1	45.51010,	-89.58476	>2 m	Lat, Long, and expected depth

Soil profile pit alternative 1	45° 30' 36.36"	-89° 35' 5.136"		Lat, Long in deg min sec
Soil profile pit alternative 2	45.510109,	-89.585372	>2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	45° 30' 36.3918"	-89° 35' 7.3392"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	No			description
Site management*	Clear cut every 40 years to make paper			description
Any additional site specific information	Regenerating young trees, actively grow (0.6 m per year)			description
Magnetic declination	2° 32' W changing by 0° 5' W/year			At time of site visit

Table 15. FCC Summary Table for FIU site components at D05 Tree Haven Relocatable 2

Site Component				**units**
Tower location	45.49457,	-89.58505		Lat, Long in degrees
Tower location	45° 29' 40.452"	-89° 35' 6.1794"		Lat, Long in deg min sec
Tower height[f]	35			meters
Tower guying	yes			yes/none, notes
Instrument Hut location	45.49465,	-89.58493		Lat, Long in degrees
Instrument Hut location	45° 29' 40.74"	-89° 35' 5.7474"		Lat, Long in deg min sec
IH orientation[a]	45º-225º			vector
boom orientation[b]	225°			degrees
distance from center of tower to IH center (z)		13	Option 1	distance (m), option #
how the Bwalk intersects the tower access	Boardwalk intersects the north-side of the tower from northeast.			description
Air shed vector(s)[c]	190° to 290° (major)	Clockwise from first angle		vector, notes
Boardwalk from AP to IH	Yes	(Fig. 6)		yes/none, notes
Boardwalk from tower to soil array	yes	No boardwalk to individual soil plots		yes/none, notes
Boardwalk needed to DFIR	no DFIR			yes/none
Power and Communication line	10 m from edge of plot to the centerline of the power/comms line	Whichever side is easiest [e], line above ground		offset, notes
DFIR location	none			Lat, Long
DFIR power supply	na.			description
Soil plot 1st location	45.494485,	-89.585261		Lat, Long in degrees (center point)
Soil plot 1st location	45° 29' 40.1454"	-89° 35' 6.9396"		Lat, Long in deg min sec
Soil plot distance between plots (x)	40 m	19 m		X, Y (meters)
Soil array pattern and vector[d]	B	240°		A, B, or C, vector, notes
Soil plot dimensions	5 m x 5 m			L x W (meters)
Soil profile pit primary	45.492550,	-89.584079	>2 m	Lat, Long, and expected depth
Soil profile pit primary	45° 29' 33.18"	-89° 35' 2.6844"		
Soil profile pit alternative 1	45.492656,	-89.583484	>2 m	Lat, Long, and expected depth
Soil profile pit alternative 1	45° 29' 33.561"	-89° 35' 0.5418"		Lat, Long in deg min sec

Soil profile pit alternative 2	45.492435,	-89.584697	>2 m	Lat, Long, and expected depth
Soil profile pit alternative 2	45° 29' 32.766"	-89° 35' 4.9092"		Lat, Long in deg min sec
Fencing needs	none	none	none	IH, Soil Arrays, Guy anchors
Presence of large grazing animals	No			description
Site management*	Selective logging			description
Any additional site specific information	Mixed northern hardwood deciduous, multiple layers of understory			description
Magnetic declination	2° 32' W changing by 0° 5' W/year			At time of site visit

Notes;
[a]parallel to the long side of the IH
[b]From tower point to this direction
[c]Clockwise from first angle, recommend reviewing FIU site characterization summary report
[d]From 1st plot toward other plots if pattern B, from 1st plot toward nearest neighbor (see diagram of the patterns)
[e]see Appendix A. Options for Soil Array, second figure.
[f]Tower Height is for FIU requirements; actual tower height will increase toward the next section height.
IH = instrument hut
AP = auxillary portal
*burn information that may affect boardwalk, IH, or tower infrastructure, or other management activities